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CONTENTS

- 105 The distribution of gaseous air pollution within museums
STEPHEN HACKNEY
- 117 The application of parylene conformal coating technology to
archival and artifact conservation BRUCE J. HUMPHREY
- 124 A new multi-purpose low-pressure conservation table for the
treatment of paintings A. M. REEVE
- 129 Determination of mineral salts from monuments A. ARNOLD
- 139 A structural solution for the preservation of canvas paintings
GUSTAV A. BERGER
- 143 Identification of ancient Persian pigments from Persepolis and
Pasargadae L. STODULSKI, E. FARRELL and R. NEWMAN
- 155 A microscope stand for the examination of easel paintings
H. LANK
- 157 BOOK REVIEWS



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A STRUCTURAL SOLUTION FOR THE PRESERVATION OF CANVAS PAINTINGS

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Abstract—Information obtained from 18 surviving panoramas and cycloramas, and a study of the behavior of canvas paintings on conventional stretchers under changing environmental conditions, have led the author to develop a new self-adjusting continuous-tension stretcher, which is described in detail.

1 Observations on the role of tension in paintings

Conservation of the Atlanta Cyclorama, the largest painting in the United States (15m × 115m), called for extensive research before and during the restoration project, which has since branched out to cover related conservation problems.

The initial investigation included gathering information on the 18 surviving panoramas and cycloramas the world over, and visiting six of them in the United States, Canada and Europe. Because they are hanging in buildings without environmental controls, cycloramas may be considered the most extensive aging and weathering tests in the history of conservation over a period of more than 100 years. Since the combined area of the six cycloramas which were personally examined by this writer amounts to that of about 30,000 medium-size paintings, they supply a wealth of information on the behavior of oil paintings on canvas which can be statistically evaluated to any desired confidence level.

Unlike most paintings brought in for conservation, where the physical history is largely unknown, where determination of their actual composition and technique is a matter of conjecture, and conclusions about the causes of their decay no more than a guess, cycloramas have proved a welcome exception for the following reasons:

- 1 Their history is known.
- 2 Their materials and technique are documented in several diaries of different artists as the standard technique of academic painting in the nineteenth century.
- 3 All are firmly attached only along their top edge, allowing the entire canvas to expand and contract freely during environmental changes.
- 4 All are stretched solely by the weight of their own painted canvas, which is constant.

As a result, the paint film at the top of each cyclorama where the tension is highest is in excellent

condition, without any cracks. Cupping and cracks appear as one approaches the bottom portions of the painting, where there is no tension. The one exception, the Mesdag panorama in the Hague, which has always had weights attached along its bottom edge, is in excellent condition throughout, in spite of the fact that the glass roof has allowed the sun to shine directly on the painting for 100 years. The condition of this panorama is the more striking since adjacent to it is a small museum housing about 50 paintings by Mesdag, which are kept on stretchers. All of them show cupping and deformations typical of paintings of the Barbizon School to which they are related.

The above observations prompted us to devote the subsequent phase of our research to measuring the dimensional changes of the Atlanta Cyclorama during variations in temperature and humidity. Within a 24-hour period, changes of over 8cm in height were measured, with a corresponding change in the painting's waist. No direct correlation between these measurements and the changes in temperature and RH could be found so the tests were repeated, and a time-lapse camera used to record them. The conclusion was to credit the unique suspension system of the cycloramas with their amazing state of preservation.

It is important to emphasize that the tension generated by the weight of the canvas is not excessive. At the top, where no cracks occurred, the calculated vertical tension is less than 200g/cm, decreasing to 100g/cm in the middle of the painting. As the canvas is stretched vertically, it contracts horizontally (Poisson Effect). The resulting stress in the horizontal direction was calculated to be 154g/cm at the top, decreasing to zero at the waist level where the first cracking occurred (this tension corresponds with that of a lightly stretched painting). Since the weight of the canvas is constant ($\pm 2\frac{1}{2}\%$), its tension remains constant at all times. This keeps the painting straight and dimensionally stable, and impedes the movements of the paint film only slightly. The canvas, stretched by constant tension in both directions, acts like a solid yet yielding support.

2 Defects of conventional stretchers

To test our conclusions, canvas samples were rigidly restrained to measure the variations in tension

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Studies in Conservation 29 (1984) 139–142

(stress) under changing environmental conditions. These were shown to fluctuate by about 100% under 'normal' environmental changes [1]. Surprisingly, even small changes in temperature (less than 1–2°C) caused stress variations of up to 20%. This means that even if a canvas restrained by a stretcher is under low tension (stress), changes of temperature and/or humidity can cause it to overstress and deform. Consequently, cycling heaters, air conditioners and humidifiers could cause overstretching many times a day, leading to a rapid slackening and eventually total loss of tension in the canvas. The canvas is no longer held straight, and begins to move with every change in stress. The paint, which has hardened meanwhile, cannot follow the movements of the canvas, and starts to crack or powder, then fall off.

Keying-out of the conventional stretchers is an attempt to regain tension. Whether done by hand or springs, it does not solve the problem (Figure 1). The canvas is expanded only at the corners, but not along the edges of the stretcher, where it is firmly held by tacks. This causes further differences in the movements of parts of the paint film. The canvas creeps and flows under the uneven stress caused by the stretcher, and folds develop in the corners. As the overstretching of the canvas continues during environmental changes, the central part over-stretches and forms a 'belly'. Following the pull of gravity, it slides down and becomes a 'hanging belly'. Attempts to restretch such a distorted canvas by keying-out are futile, and may result in diagonal tears in the corners. Many color field paintings have already reached this stage.

3 The self-adjusting continuous-tension stretcher*

In view of the above findings, William Russell, Professor of Architecture at the Georgia Institute of Technology, assisted us with stress measurements and in the design of a new type of stretcher which would imitate the suspension system of the cycloramas and provide uniform tension in the painting (Figure 2).

The self-adjusting continuous-tension stretcher consists of the following parts:

- 1 A rigid frame, or strainer (no. 1 in Figure 2).
- 2 A horizontal, movable top member (no. 2), connected to the rigid frame with vertical springs (no. 3) which enable it to move up and down in the vertical direction. The top member imparts a gentle and continuous vertical tension to the entire painting.
- 3 A Teflon tape (no. 4), covering both vertical edges of the strainer, provides a low-friction

surface which facilitates movement of the stretched canvas. As a result, expansion and contraction of the canvas along the vertical bars is unrestrained (as opposed to all other stretchers), and uniform tension is generated by the moving top member from one end of the painting to the other.

- 4 Two sleeves (no. 5), each containing one aluminum bar (no. 6), are attached to the vertical margins of the painting by way of strip-lining.
- 5 Horizontal springs (no. 7) provide tension in the horizontal direction. This tension is evenly distributed with the help of the aluminum bars (no. 6) over the entire vertical extension of the canvas.

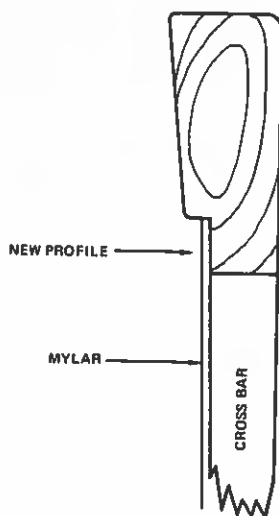


Figure 3 Cross-section of stretcher bar.

A special feature of the new stretcher is the additional beveling of the inside of the bars (Figure 3), which allows a sheet of Mylar or canvas to be attached. This sheet serves as a barrier against change in temperature and RH, and also to protect the painting from impact with the cross-bars.

The self-adjusting continuous-tension stretcher permits the canvas to absorb changes in temperature and RH with a minimum increase in stress. It reduces peak loads by more than 70%, and the springs protect the painting from the shocks of frequent environmental changes the way springs in a car protect it from the jolts of the road.

By not being restrained along its vertical edges, the entire canvas can expand uniformly and, as a result, the stress is evenly distributed all over the surface of the painting. The tension exerted in the horizontal direction is sufficient to absorb expan-

*Patent pending.

sions and contractions, and eliminates the occurrence of folds in the corners. Sagging caused by gravity is also absorbed by the vertical springs.

Since the new stretcher does not open at the corners, it is stronger, more resistant to warping, and easier to build than the conventional stretchers. It may be made of metal, thus postponing almost indefinitely the need for special care or maintenance treatment. Therefore, it should be particularly useful for paintings kept in public buildings with little or no environmental controls, or in places which are hard to reach.

Many modern paintings are made of the most unusual materials, and have such delicate surfaces that, as of this writing, no satisfactory consolidation methods have been found to preserve them. The new stretcher provides an alternative which promises to slow, or possibly prevent, cracking and distortions. Obviously, a method which leaves the painting untouched is preferable to any other treatment currently in use, such as ironing, lining or mounting on a honeycomb panel.

Modeled after the suspension system of the cycloramas, the continuous-tension stretcher is expected to protect canvas paintings from cracking for many years.

Reference

- 1 RUSSELL, W. H., and BERGER, G. A., 'The behavior of canvas as a structural support for painting: pre-

liminary report' in *Science and Technology in the Service of Conservation*, IIC, London (1982) 139-145.

GUSTAV A. BERGER, born 1920. Studied art in Vienna, civil engineering at Haifa Technical Institute, and later art restoration in Bologna. Worked as photogrammetrist at the Photogrammetric Institute in Jerusalem. In New York he was assistant to Mario Modestini and later to William Suhr. In 1965 he began research on adhesives for the consolidation of paintings, supported by grants from the Samuel H. Kress Foundation. After developing a new adhesive, Beva 371, he went on to investigate and develop other materials for use in conservation. He has headed his own studio since 1966. *Author's address: Berger Art Conservation, Inc., 1014 Madison Avenue, New York, NY 10021, USA.*

Résumé—L'étude de 18 panoramas et cycloramas, rapprochée de celle du comportement des peintures sur toile sur chassis classique soumises à diverses conditions climatiques, ont conduit l'auteur à mettre au point un nouveau type de chassis à tension auto-régulée qui est décrit en détail dans ce mémoire.

Auszug—Von 18 überlebenden Panoramas und Zykloramas und einem Studium des Verhaltens von Leinwandölgemälden auf herkömmlichen Streckvorrichtungen unter wechselnden Umgebungsbedingungen erhaltene Informationen haben den Autor bewegt, einen neuen, selbsteinstellenden Konstantspannungs-Spannvorrichtung zu entwickeln, die eingehend beschrieben wird.